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# Environmental Management at Sustainable Airport Models

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# ENVIRONMENTAL MANAGEMENT AT SUSTAINABLE AIRPORT MODELS

by

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B.S., Southern Illinois University Carbondale, 2006

A Research Paper

Submitted in Partial Fulfillment of the Requirement for the  
Masters of Public Administration

Public Administration Program  
in the Graduate School  
Southern Illinois University Carbondale  
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RESEARCH PAPER APPROVAL

ENVIRONMENTAL MANAGEMENT AT SUSTAINABLE AIRPORT MODELS

By

Dora-Anne A. Asinjo

A Research Paper Submitted in Partial

Fulfillment of the Requirements

for the Degree of

Masters of Public Administration

in the field of Aviation

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## AN ABSTRACT OF THE RESEARCH PAPER OF

DORA-ANNE A. ASINJO, for the Master of Public Administration degree in Aviation Administration, presented on 4<sup>th</sup> April, 2011, at Southern Illinois University Carbondale.

TITLE: Environmental Management at Sustainable Airport Models

MAJOR PROFESSOR: Dr. David A. NewMyer

Airports experience greater environmental challenges when they develop and/or expand, presenting more opportunities for greener options. Due to higher demand and capacity needs, there is an increase in airport activities especially at commercial service airports. Consequently, the increase in airport related activities means an increase in environmental impacts. To address environmental issues, airports practice environmental management and commonly use an Environmental Management Systems (EMS). Several commercial service airports have gone beyond the minimum compliance requirements of the International Organization for Standardization (ISO) 14001 and / or the National Environmental Policy Act (NEPA) and / or applicable nation, state, federal and local requirements. These commercial service airports have established innovative Environmental Management Programs (EMP), serve as examples and are considered *sustainable airport models*. The purpose of this paper is to identify (1) *sustainable airport models* and their (2) environmental management programs and practices established through EMS. (3) Recommend suitable methods, practices and EMP that other commercial service airports can use to improve and /or initiate sustainable environmental practices. These airports have a similar approach to environmental management with long term planning for sustainability. U.S. commercial service airports are capable of addressing environmental issues through similar methods and programs established at the *sustainable airport models*.

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## INTRODUCTION AND PURPOSE

Airports experience greater environmental challenges when they develop and/or expand, presenting more opportunities for greener options. According to the Boeing Current Market Outlook report, worldwide passenger traffic growth between 2001 and 2009 averaged at 5% annually. There was a decline in 2009 because of the economic downturn. Nevertheless, the average passenger growth rate in this past year, 2010, rose to 6% and is forecast to continue at an average of 5.3% between 2009 and 2029 while cargo is forecast at 5.9% (Boeing Management Company , 2010). Due to higher demand and capacity needs, there is an increase in onsite and offsite airport activities especially at commercial service airports. Consequently, the increase in airport related activities means an increase in environmental impacts.

This research developed from the Airport Cooperative Research Program (ACRP) report “Airport Sustainability Practices,” which recommends in-depth research and creation of sustainability guidelines for all airports in environmental, social and economic sustainability (Transportation Research Board, 2008).

The purpose of this paper is to identify (1) *sustainable airport models* and their (2) environmental management programs and practices established through Environmental Management Systems (EMS). (3) Recommend suitable methods, practices and Environmental Management Programs (EMP) that other commercial service airports can use to improve and /or initiate sustainable environmental practices.



## LITERATURE REVIEW

### I) Environmental Sustainability: Identifying Necessities

Airports experience greater environmental challenges when they develop and/or expand, presenting more opportunities for greener options. According to the Boeing Current Market Outlook report, worldwide passenger traffic growth between 2001 and 2009 averaged at 5% annually. There was a decline in 2009 because of the economic downturn. Nevertheless, the average passenger growth rate in this past year, 2010, rose to 6% and is forecast to continue at an average of 5.3% between 2009 and 2029 while cargo is forecast at 5.9% (Boeing Management Company, 2010). Due to higher demand and capacity needs, there is an increase in onsite and offsite airport activities especially at commercial service airports. Consequently, the increase in airport-related activities means an increase in environmental impacts.

The Transportation Research Board (TRB) conducted a study under the ACRP on airport sustainability practices. In the study defines *airport sustainability* as, practices ensuring the protection of the environment, social progress and the maintenance of stable levels of economic growth and employment (Transportation Research Board, 2008). Moreover, the results of the study indicate that, environmental practices are the main challenge for airports in the U.S., Canada, Europe and Asia. The study's recommendation calls for in-depth research and creation of sustainability management guidelines for all airports in environmental, social and economic sustainability. The Sustainable Aviation Guidance Alliance (SAGA) presents several definitions of airport sustainability in the Sustainable Aviation Resource Guide. The definitions are drawn from the TRB (above), Brundtland Commission and the ACRP. Thus, the Airports Council International – North

America has an inclusive airport sustainability definition “...a holistic approach to managing an airport so as to ensure the integrity of the economic viability, operational efficiency, natural resource conservation and social responsibility (EONS) of the airport (SAGA, 2010, p. 8).” Moreover, an airport’s sustainability definition, approach and practices should comprise of specifics based on locale, size, operations, ecological environs, stakeholders and surrounding community. Environmental sustainability planning mitigates or eliminates negative impacts and facilitates optimum planning for future developments.

The SAGA created general sustainability management practices guideline, which are applicable to all three key areas of airport sustainability identified by the TRB as, environmental, social and economic. However, it does not separately address key elements for environmental sustainability management and EMS implementation, which is an integral part of environmental planning that aids in identifying EMP funding. On the other hand, the SAGA sustainability database lists practices associated with environmental management, which is useful as startup and benchmarking tool based on targeted goals, results and outcome of practices. The database is a combination of over one thousand sustainable practices of several airports. The sources include, airport sustainability manuals, professional airport groups, government agencies and standard sustainability manuals (Sustainable Aviation Guidance Alliance (SAGA), 2010).

As noted from the studies by TRB and SAGA, identifying sustainable environmental management practices are essential in mitigating the negative environmental impacts at all airports. Moreover, airport environmental programs and practices are mandated by law to ameliorate or eliminate negative environmental impacts.

Airports need to modify and continually adapt to new policies and practices, and because of the awareness of sustainability across all industries. The FAA has also launched a “Sustainable Master Plan Pilot Program,” which is an effort to making sustainability the main goal at every airport. The pilot program is comprised of ten airports<sup>1</sup> of differing categories in terms of size and operations. Additionally, the FAA utilizes the ACRP report and SAGA database as a reference for the sustainable pilot program (Federal Aviation Administration, 2011).

Janic identifies four environmental externalities as air pollution, noise, safety and congestion and delays particularly around busy airports (Janic, May 1999). Janic’s conclusion is that, over the years civil aviation has been developing sustainably, based on analyses of air pollution, noise, safety, congestion and delays. Moreover, policies have facilitated airport sustainability by supporting innovations, optimal use of existing technology and developing new technology. However, more resources are used and more waste is generated as the number of passengers and demand for air travel increases (Janic, May 1999). Therefore, Janic’s findings indicate that aviation may not be developing sustainably as suggested and illustrated by the increase in demand and unequal increase in waste. Congestion due to capacity constraints causes inefficiency for airports, airlines and thus, waste in energy and materials used to combat congestion and limited capacity.

In an analysis of U.K. and European airports’ policy and sustainability practices, Upman found that, the airports are more committed to mitigation in order to meet the

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<sup>1</sup> Airports participating in the Sustainable Pilot Program are: Denver International Airport, Fresno Yosemite International, Hartsfield-Jackson Atlanta International Airport, Nashville International Airport, Newark Liberty International, Newport News/Williamsburg International Airport, Newton City-County Airport, Outagamie County Regional Airport, Renton Municipal Airport and Teterboro Airport (Federal Aviation Administration, 2011).

basic regulatory compliance standards. Most U.K. airports viewed sustainability as, “...the consideration of environmental and social impacts alongside environmental and financial performance (Upham, 2001, p. 11).” However, sustainability generally aims at the overall reduction in environmental impact and reduction in consumption, waste, and efficiency in environmental practices. The analysis found that, under unchanged technological conditions, and with an increase of passengers, there is an increase in waste as expected but also increase in waste per passenger (Upham, 2001). This is similar to Janic’s findings and it shows the need for environmental sustainability strategies that will equally meet demand for air travel, mitigate and prevent negative environmental impacts. These strategies and practices range from energy savings to, fuel efficiency, to Leadership in Energy & Environmental Design (LEED) building technology and many others, based on the SAGA and ACRP report “Sustainable Airport Construction Practices” (Transportation Research Board, 2011). Moreover, an analysis of innovative environmental practices and management systems is essential in developing efficient and sustainable practices for all categories of airports. That is, commercial service, reliever and general aviation airports as defined in the National Plan of Integrated Airport Systems (NPIAS) (Federal Aviation Administration, October 2010).

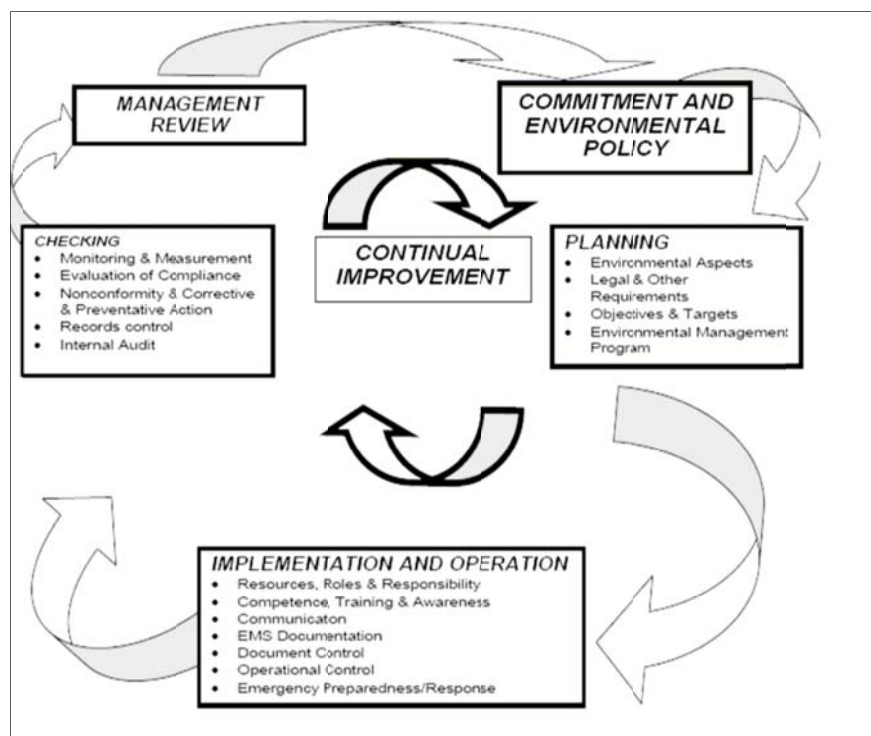
## **II) Environmental Practices and Management Systems**

According to the Advisory Circular (AC) 150-5050-8 Environmental Management Systems (EMS), originated as a response to the Executive Order 13148, “Greening the Government Through Leadership in Environmental Management,” in April 2000. The FAA’s definition of an EMS is a management practice allowing organizations to strategically address environmental issues. Corporate environmental

practices can be categorized into two; EMS and the life-cycle assessment. The life-cycle assessment ensures achievement of an airport's current environmental goals (Federal Aviation Administration Planning and Environmental Division, 2007).

The International Organization for Standardization (ISO) 14000 and consequent series 14001 and ISO 14001:2004 are international environmental certification standards for any EMS (Environmental Protection Agency, 2011). According to the AC 150-5050-8 Environmental Management Systems for Airport Sponsors, the majority of the U.S. commercial service and several general aviation airports' management practices and systems meet the ISO 14001 standards for environmental certification and registration. The Federal Aviation Administration (FAA) requires that, airports implementing an EMS should show compliance and ISO 14001 certification. EMS implementation reflects accepted management principles based on the "Plan, Do, Check, Act," model. That model is a systematic process to identify goals, complete them, determine progress, and make changes to ensure continual improvement" (FAA Planning and Environmental Division, 2007, p. 1.) In the AC 150-5050-8 Environmental Management Systems for Airport Sponsors, an EMS is comprised of five components that satisfy the "Plan, Do, Check, Act" model. These are first, commitment to an environmental policy, commonly dictated by the National Environmental Policy Act (NEPA) and the airport management's commitment to fulfill the policy requirements. Second, is identifying how the airport impacts the immediate and surrounding environment. During this phase, the team performs a cost/ benefit analysis based on various aspects such as operations, size, and location. Third, is outlining the implementation plans for EMP, the practices or programs that define the EMS. The responsibilities assigned to the environmental team and the

EMP progress, results and outcomes are documented. Fourth, is checking if the EMP meets the airport's goals and most important, NEPA regulations and airport policies. Corrective action often occurs at this stage of the EMS through the established procedures of the ISO 14001 or airport policies and procedures. Fifth, a final review and audit phase allows the airport management to address the strengths and the weakness of the EMP in place (Federal Aviation Administration Planning and Environmental Division, 2007). Any additional environmental needs are included in the consequent cycles. *Figure 1* illustrates the components of an EMS and the Plan, Do, Check, Act model as described in the AC 150/5050-8, Environmental Management Systems for Airport Sponsors.



*Figure 1.* The five components of an EMS

Source: FAA AC 150-5050-8 Environmental Management Systems for Airport Sponsors (Federal Aviation Administration Planning and Environmental Division, 2007).

### III) A Global View of Environmental Management

The *sustainable airport models* progressively modifying EMP to accommodate changes that aid in mitigating the environmental impacts. Seattle-Tacoma, Dallas Fort Worth, Denver, Chicago O'Hare, Portland, Fort Lauderdale, Munich, Oslo, and Athens are a few selected examples of *sustainable airport models* with innovative EMPs. These airports are innovative through utilization of available resources, technology, partnership with research organizations and government agencies to develop environmental programs as part of their EMS. For instance, Seattle Tacoma and Dallas Fort Worth have accommodated environmental awareness and changes through the Green Airport Initiative (GAI), which assists airports with improving environmental quality. GAI is a program developed by the Clean Airport Partnership co-operation. Examples of innovative EMP are; Seattle-Tacoma and Portland have established a clean vehicle program, Dallas/ Fort Worth programs encompass several tasks to lower emissions. Munich tests alternative fuels including hydrogen, to mention a few. Airports are also constructing or modifying their terminals and buildings and using environmental friendly materials. Additionally, Boston Logan international was one of the first airports to get a U.S. Green Building LEED certification (Fortmeyer, 2001). The concept is now widely embraced by majority of airports undergoing new construction and renovation such as Chicago O'Hare, San Francisco and Honolulu (Transportation Research Board, 2011).

As the air traffic increases, creating capacity problems, the demand for facilities also arise. As a solution, there have been expansions of existing airports while some airports have replaced those that had exceeded their capacity to handle the demand. These new airports are known as "green airports" because they are built at new sites. As a result

these new airports have eased congestion due to more capacity, eased traffic and ground transportation problems, and are a positive economic impact. Examples of the airports built on new sites are, Munich, Denver International, Oslo Gardermoen and Athens (Dempsey, 1999). As identified, these four airports have developed innovative EMP. The other *sustainable airport models* are those experiencing capacity constraints or tackling renovation and technological upgrades to meet the demand and efficiency needs. On a national level, the selected airports are Denver, Dallas-Fort Worth, Chicago O'Hare, Portland, Seattle Tacoma and Fort Lauderdale. On the international level, they are Munich, Athens and Oslo. The selected airports, their 2009 passenger enplanements and total counts are listed in Table 3 *Sustainable Airport Models* and Table 5 *Innovative Environmental Management Practices and Programs at Sustainable Airport Models*.

There are some challenges as airports take initiative towards sustainability. This, it is important to understand some of the sustainability implementation and practices challenges prior to analyzing the benefits and efficiencies. Other beneficial elements are the significant factors stimulating and supporting airport sustainability practices. These hindrances and catalysts help airports organize and focus their current practices towards realistic and attainable goals.

#### **IV) Hindrances and Catalysts of Environmental Sustainability Practices**

The "Airport Sustainability Practices" report, published in the ACRP Synthesis 10, identifies some of the catalysts, barriers of sustainability, and future sustainability practices in environmental, economic and social airport practices (Transportation Research Board, 2008). Airports surveyed indicated regulations and policies as key catalysts for sustainability practices. Additionally, the airports ranked regulations and



policies in order of importance. From the most important to least are as follows, state/regional regulations, airport policy, federal regulations and corporate responsibility.

Furthermore, the future catalysts of sustainability are identified as, stakeholders' concerns, global trends, airport policy, and corporate responsibility. In both cases, current and future catalysts, airport policy and corporate responsibility are important factors that promote airport sustainability practices. The ACRP study focuses on three sustainability areas, environmental, economic and social airport practices. However, the results show that environmental sustainability is a key priority for airports, currently and in the future. Some of the identified sustainable practices are energy, green buildings and climate change (Transportation Research Board, 2008). Table 1 from the ACRP Airport Sustainability Practices report, summarizes the current and future catalysts for sustainability practices.

Table 1  
*Current and Future Catalysts for Sustainability Practices*

PROPORTION OF RESPONDENTS FROM U.S. AND NON-U.S. AIRPORTS WHO SELECTED THE TOP FIVE CURRENT DRIVERS FOR SUSTAINABILITY PRACTICES							PROPORTION OF RESPONDENTS FROM U.S. AND NON-U.S. AIRPORTS WHO SELECTED THE TOP FIVE FUTURE DRIVERS FOR SUSTAINABILITY PRACTICES						
	Airport Size	Current Driver for Sustainability Practices						Airport Size	Future Driver for Sustainability Practices				
		State/Regional Regulation	Airport Policy	Federal Regulation	Corporate Resp.	Stakeholder Concerns/ Relations			Stakeholder Concerns/ Relations	Global Trends	Airport Policy	Corporate Resp.	Federal Regulation
% Respondents	U.S. Airports						% Respondents	U.S. Airports					
	Non-Hub (1)	100%	100%	100%	0%	0%		Non-Hub (1)	100%	0%	0%	0%	100%
	Small Hub (2)	50%	0%	50%	0%	50%		Small Hub (2)	50%	0%	0%	0%	50%
	Medium Hub (4)	75%	50%	50%	100%	75%		Medium Hub (4)	100%	75%	50%	75%	75%
	Large Hub (9)	89%	78%	33%	56%	56%		Large Hub (9)	56%	44%	56%	44%	33%
	Non-U.S. Airports							Non-U.S. Airports					
	Continental Europe (5)	100%	80%	60%	40%	20%		Continental Europe (5)	40%	60%	40%	60%	40%
	Asia (1)	0%	100%	0%	100%	100%		Asia (1)	100%	100%	100%	100%	0%
	United Kingdom (1)	100%	0%	0%	0%	100%		United Kingdom (1)	100%	100%	100%	100%	0%
	Canada (2)	0%	0%	100%	100%	100%		Canada (2)	100%	50%	100%	100%	50%

Source: ACRP Synthesis 10: Airport Sustainability Practices (Transportation Research Board, 2008).

The ACRP Airport Sustainability Practice report outlined sustainability hindrances from the most challenging to the least. In that order, these hindrances comprise of funding, staffing, management, culture and training. Table 2, from the Airport Sustainability Practices report, summarizes the hindrance to implementation of sustainability practices. In a 2004 report to Congress, “Aviation and the Environment,” the FAA and NASA presented a plan to invest \$10 million per year for the development of comprehensive environmental analysis tools for noise and air quality (Waitz, Townsend, Cutcher-Gershenfeld, Greitzer, & Kerrebrock, December 2004). The results of the investment are several studies and synthesis publications on emissions. These studies were achieved through cooperative effort between airports, airport groups and government agencies. The 2004 “Aviation and Environment” report discusses the differences between the European and U.S. approach in addressing environmental challenges. The European approach was the creation of Advisory Council for Aeronautics Research (ACARE), which coordinates environmental strategies and actions. Contrarily, the U.S. is addressing environmental challenges via cross agency programs. The report concludes with three recommendations for the promotion of environmental sustainability. These are coordination and communication, effective tools metrics and technology, operations and policy actions (Waitz, Townsend, Cutcher-Gershenfeld, Greitzer, & Kerrebrock, December 2004). Technology, operations and policy action is the key recommendation with several associated projects, for example, the Voluntary Airport Low Emissions (VALE) program funded under an Airport Improvement Program (AIP). Though airports are faced with challenges implementing environmental sustainability

plans, several agencies and groups are providing their support and input through research, for example the ACRP.

Table 2

*Hindrances to Implementation of Sustainability Practices*

PROPORTION OF RESPONDENTS FROM U.S. AND NON-U.S. AIRPORTS IDENTIFYING KEY BARRIERS TO IMPLEMENTATION OF SUSTAINABILITY PRACTICES						
	Airport Size	Barrier To Sustainability Practices				
		Funding	Staffing	Management	Culture/Behavior	Training/Understanding/Knowledge
% Respondents	U.S. Airports					
	Non-Hub (1)	100%	0%	0%	0%	0%
	Small Hub (2)	50%	0%	50%	0%	0%
	Medium Hub (4)	75%	0%	0%	25%	0%
	Large Hub (9)	56%	33%	11%	22%	33%
	Non-U.S. Airports					
	Continental Europe (5)	60%	0%	20%	20%	0%
	Asia (1)	100%	0%	0%	0%	0%
	United Kingdom (1)	100%	0%	0%	0%	0%
	Canada (2)	50%	50%	50%	0%	50%

Source: ACRP Synthesis 10: Airport Sustainability Practices (Transportation Research Board, 2008).

## METHODOLOGY

All the selected airports are commercial service, categorized as large and medium hub airports. These airports face the greatest environmental challenges due to the nature of operations, immediate surroundings and were built on new sites, and are undergoing renovation and / or expansions. Analyzing the EMS and EMP at these airports facilitates an understanding of environmental practices at the busy commercial service airports. Additionally, the analysis will aid in creating general guidelines or a model that is applicable to other commercial service airports particularly those with similar resources. For example, the FAA Sustainable Pilot Program previously mentioned. Other airports will be able to consult the guidelines or models for current and future environmental sustainability planning.

The U.S. airports comply with the Federal Aviation Regulations and the NEPA requirements and FAA EMS guidelines, while the European airports comply with the national as well as European Environment Agency (EAA) regulations. However, both address common environmental issues and have similar approaches to environmental sustainability. The assumption is that, the size and operations of the airports are key factors to the similar approaches for environmental sustainability planning. Each *sustainable airport model* offers a unique program or practices applicable to other commercial service airports. The following are factors used to identify the *sustainable airport models*.

1. Does the EMS contain the five basic components and follow the Plan, Do, Check, Act model? These five components are commitment to environmental policy, airport

- impact to surrounding environment, EMP implementation plans, monitoring the EMP and outlined goals and audit and review of the EMP.
2. Does the EMP address ongoing changes in environmental awareness and policy initiatives? The selected airports took initiative and advantage of environmental research and program opportunities.
  3. Does the airport show development towards environmental sustainability planning, through regular evaluation and/or anticipation of new environmental regulations and policies? The selected airports published the outcomes of their EMP and initiatives for new or improvement on the current EMP.
  4. Are the airport's environmental practices in the SAGA database? All the *sustainable airport models*' practices are in the SAGA and some are identified as successfully sustainable airports such as Denver, Chicago O'Hare and Seattle-Tacoma.

Table 3  
*Sustainable Airport Models*

<b>SUSTAINABLE AIRPORT MODELS</b>			
<b>National Airports</b>	<b>ICAO Identifier</b>	<b>IATA Identifier</b>	<b>2009 Enplanements<sup>2</sup></b>
<b>Denver International<sup>1</sup></b>	KDEN	DEN	24,005,992
<b>Dallas/ Fort Worth International</b>	KDFW	DFW	26,663,984
<b>Chicago O'Hare International</b>	KORD	ORD	31,135,732
<b>Portland International</b>	KPDX	PDX	6,430,119
<b>Seattle-Tacoma International</b>	KSEA	SEA	15,273,092
<b>Fort Lauderdale/ Hollywood International</b>	KFLL	FLL	10,234,872
<b>International Airports</b>			<b>Total Passengers<sup>3</sup></b>
<b>Munich Franz Josef<sup>1</sup></b>	EDDM	MUC	32,618,067
<b>Oslo Airport<sup>1</sup></b>	ENGM	OSL	18,087,722
<b>Athens International<sup>1</sup></b>	LGAV	ATH	16,225,885
<sup>1</sup> Built on a green site (Dempsey, 1999)			
<sup>2</sup> Source: FAA CY09 Enplanements at Commercial Service Airports			
<sup>3</sup> Source: Airports Council International			

The SAGA environmental sustainability database serves as a guide for defining and selecting EMP criteria used in identifying the *sustainable airport models'* practices. The database contains over a thousand environmental practices from North American, European and Asia airports. Additionally, the database also has practices identified in the Airport Sustainability Practices report (Sustainable Aviation Guidance Alliance (SAGA), 2010). The following section is a description and analysis of the recognized EMS and EMP of national and international *sustainable airport models*.

## ANALYSIS

### **I) Future of Environmental Practices**

Currently, all transportation sectors and other industries are more environmentally aware; thus they are modifying policies, practices and standards to comply with regulations to lessen negative environmental impacts. For example, the Center for Transportation Analysis published an overview of greenhouse gas emissions contributed by each mode of transportation, in the U.S., with an aim of seeking alternatives with less greenhouse gas emissions. Combined, transportation produces approximately 33% of greenhouse gas emissions while Air transportation produces 11% (Center for Transportation Analysis, 2010). Airports face environmental challenges such as; aircraft and ground vehicles and noise levels, emissions, air quality, water quality, energy use, land uses near airports and the use of surface transportation. Additionally, increase in passenger use also causes an increase in waste, water and energy environmental impacts. According to Kaszewski and Sheate (2004), there are two categories of environmental effects global effects and local effects. The global effects include emissions from aircraft, aerosols and land acquisitions. The local effects include aircraft operations, ground operations, surface access transportation, surface run-off and airport location. To address these issues, airports practice environmental management as per the policies and procedures and commonly use an EMS. An airport's environmental practices and programs usually evolve from the guidelines found in the EMS. Kaszewski and Sheate found that, a plan comprising of a green transport plan, green architecture plan and use of renewable energy is the most suitable approach for tackling environmental challenges and improving airport sustainability. The stand-alone options are, "business as usual

approach”, “green transport plan” and “green architecture plan.” A green transport plan comprises of practices that lessen the environmental impact with use of the current infrastructure and best environmental policies. Additionally, green architecture is incorporation of best green building technology to infrastructure improvements and new buildings (Kaszweski & Sheate, 2004).

All U.S. commercial service airports, receiving federal funding, have gone beyond the minimum environmental compliance requirements of the ISO 14001 and / or the NEPA and / or applicable nation, state, federal and local requirements. These commercial service airports have established innovative EMP, serve as examples, and are considered *sustainable airport models* (Sustainable Aviation Guidance Alliance (SAGA), 2010). The SAGA, Sustainable Aviation Resource Guide, identified successful sustainability programs at different airports. The successful airport programs’, practices and criteria were used to build the SAGA sustainability database. Examples are Los Angeles airports, Chicago O’Hare, Boston-Logan, San Francisco, Seattle Tacoma, Denver, Albany, Vancouver, New Chitose (Japan), Budapest International among others. Other sources of sustainability practices are sustainability construction guidelines, the ACRP Synthesis 10 “Airport Sustainability Practices” and Airports Council International (ACI) (Sustainable Aviation Guidance Alliance (SAGA), 2010). The *sustainable airport models’* EMS have the general characteristics necessary for airport environmental management of the global and local effects, which are noise, air quality, water quality, energy, waste, hazardous materials, climate change, habitat, heritage and wetlands management. Each EMS is tailored to an airport’s surrounding environment and the EMP address the airport’s challenges. The *sustainable airport models* follow the basic



principles of the Plan, Do Check, Act model and are modified as needed to address further issues arising from airport changes and development. Table 4 is a summary of the sustainability practices and criteria of the *sustainable airport models*.

The *sustainable airport models*' innovative EMPs meet the ISO 14001 environmental certification standards, NEPA requirements, state and local and abide by additional requirements established by the governing nation's environmental bodies. Examples of certifications and programs are, Green Airports Initiatives, U.S. Green Building LEED, Vehicle Emissions programs under the VALE program, German Air Transport Initiative etcetera. *Sustainable airport models* characteristics mainly comprise of the criteria presented in Table 4. However, they are not limited to this list since the SAGA database contains over one thousand sustainability practices.

*Sustainable airport models* set the standards for future EMPs because they serve as examples to many airports. However, creating a tailored program is a challenge particularly for small general aviation airports due to availability of resources. General implementation guidelines are outlined in the FAA "Order 5050.4B NEPA Implementing Instructions for Airport Actions" (Federal Aviation Administration Office of Airports (ARP), 2006). The document lists some of the NEPA regulations that all public use airports are required to comply with when planning or proposing any major developments (see Appendix B, Table B1 for list of regulations). In the following sections is an analysis of the *sustainable airport models* and their innovative programs. These airports, identified through their EMS and EMP, show a commitment to promoting and mitigating environmental impacts. Furthermore, they take into account the regulatory and policy changes expected to occur in the near future. In a 2010 report for the U.S. Congress, by

McCarthy, the issue addressed is, “aviation and climate change.” The Green House Gas Legislation is a priority and the report recommends green house gas emission regulation through the Clean Air Act (McCarthy, 2010). Some of the innovative EMP are progressive steps by *sustainable airport models* towards addressing the issues outlined in the report to Congress.

Table 4

*A Summary of Management Practices and Criteria of Sustainable Model Airports*

<b>Category</b>	<b>Sustainability Practices and Criteria</b>
Administrative	policies, procedures and plans, community outreach, human resources
Stormwater management	erosion and sediment control, rate and quality, treatment, deicing facilities, operations, pollution prevention plan
Water efficiency	water management plan, waste water technologies and water use reduction
Ground Transportation	public transportation access, alternative fuel vehicles, parking capacity, roadway design
Landscape and exterior design	light pollution reduction, water efficient landscaping
Energy efficiency and atmosphere	systems commissioning, minimum energy performance, optimize energy performance, chlorofluorocarbon reduction
Indoor environmental quality	tobacco smoke control, carbon dioxide monitoring, ventilation effectiveness, low-emitting materials, chemical and pollutant source control, noise transmissions
Facility operations	operations, maintenance and equipment, site selection and restoration, brownfield and contaminated site redevelopment, exterior air quality, noise, vegetation and wildlife management
Materials and resources	waste reduction, storage collection of recyclables, structure, building reuse
Construction practices	sustainable construction project report, implement sustainability inspection program, construction scheduling and sequencing, construction waste management, recycled content, use of local or regional material, rapidly renewable materials, planning for deconstruction, disassembly and flexible use of space, construction health and safety

### **A) Denver International Airport**

Denver International Airport opened in 1995 and in 2009, it had 24 million passenger enplanements (Federal Aviation Administration Planning and Environmental Division, 2011). It was one of the first airports on the Environmental Performance Track program, due to its outstanding quality in environmental management. Denver International Airport's EMS is comprised of approximately twenty-one programs and continues to expand. Its EMS is one of the few that cover the entire scope of the airport (Denver International Airport, 2009). Some of these programs address environmental challenges such as, aircraft deicing, liquid fuel, hazardous waste, wetlands, emissions and bird migrations. To assist their workers reduce the environmental impact of their activities, Denver has a comprehensive environmental guideline publication. Planning and design, tenant operation, fueling aircraft are few examples of the activities covered in the document. The airport recycles aircraft deicing fluids and prevents the discharge of contaminated water through a capturing system and wastewater retention ponds (Denver International Airport, March 2010).

Denver International Airport's alternative energy and conservation project includes a photovoltaic installation, eco-starts on escalators and implementing master energy study. Some of the future initiatives include replacing gasoline vehicles with gas or electric hybrid vehicles, testing hydrogen systems similar to Munich airport, and a wind-monitoring program for future use as renewable energy (Denver International Airport, March 2009).

## **B) Dallas/ Fort Worth International Airport**

Dallas/ Fort Worth International Airport began commercial service in 1974 and had 26 million passenger enplanements in 2009 (Federal Aviation Administration Planning and Environmental Division, 2011). The airports core environmental compliance programs are air quality, water quality, solid waste, health, safety and wildlife management. Dallas/ Fort Worth International Airport is known for air quality programs for lower emissions and energy efficiency. Part of the airport environmental policy is, reviewing air quality impacts and implementation or improvement of programs such as alternative fuel vehicles, which has grown to a fleet of more than one hundred vehicles (Dallas/ Fort Worth International Airport, June 2002). The 2002 EMS' goal is "environmental excellence through pollution prevention." The subsequent 2009 report follows up on the achievements and analyses the progress towards sustainability. Embracing evolving technology, policy changes and training are some factors that have helped the airport establish notable emissions programs (Dallas/ Fort Worth International Airport, April 2009). Moreover, the airport has employee training on environmental policy and general awareness. In 2009, the airport was awarded for environmental education and community involvement (Airports Council International - North America, 2010).

## **C) Chicago O'Hare International Airport**

Chicago O'Hare International Airport is the second busiest airport in the nation and serves the Midwest. It had 31 million passenger enplanements in 2009 (Federal Aviation Administration Planning and Environmental Division, 2011). The airport faces environmental challenges because of demand and the ongoing construction to meet

demand. The O'Hare Modernization Program (OMP) created the Sustainable Airport Manual to avoid, mitigate and minimize the environmental impacts resulting from airport expansion, operations and other developments. This comprehensive manual, updated in 2009, has become a model guide to many airports facing similar challenges. Water efficiency at the airport is one example practice that can be borrowed by any other commercial service airport. The airport minimizes waste through sensor technology and collection of rainwater, stormwater, air conditioning condensation and recycling of greywater. Other challenges addressed by the manual are recycling, energy efficiency and brownfield development, which is the reuse of land (City of Chicago, August 2009).

#### **D) Portland International Airport**

Portland international Airport is a medium hub airport enplaning more than 6 million passengers in 2009 (Federal Aviation Administration Planning and Environmental Division, 2011). Since the adoption of Portland International Airport environmental policy in 2000, the airport continues involvement with the community and stakeholders. Reduction of waste, on and off the airport resulted in a recycling program which is a cooperative effort involving the city and the community residents. Additionally, the city provides a "green building" training series for educating construction professionals. Portland International Airport, the city and ports authority recently addressed sustainability planning addressing three areas, environmental, economic and social development. The long-range plan focuses on land-use, which involved the communities' input and visions for the airport and city's future (Portland International Airport, July 2010). A few of the focus areas are, the urban renewal areas, cultural resources, recreation and open space, wildlife habitat and water quality which all

promote natural resource conservation. Operational efficiency areas are parking, rental cars, terminal area roadways, cargo facilities and general aviation (Portland International Airport, July 2010).

#### **E) Seattle-Tacoma International Airport**

Seattle-Tacoma International Airport had 15 million passenger enplanements in 2009 (Federal Aviation Administration Planning and Environmental Division, 2011). The airport participates in the VALE program and it will be one of the first with an all non-gasoline or electric ground support fleet. Seattle-Tacoma International Airport received 5 million dollars from the Department of Energy to convert the vehicles and construct the electric vehicle charging stations. Another recognized program is its stormwater management program, developed at the cost of 80 million dollars for a drainage basin plan for the Des Moines Creek. The project prevents pollution into the basin and cleans collected stormwater. Furthermore, wetland and stream mitigation facilitated the restoration of habitat associated with impacts from runway construction (Port of Seattle, 2009-2010). The airport is one of the few able to recycle twenty-three percent of solid waste and, aims for a fifty percent rate by 2014 (Port of Seattle, 2009). Seattle-Tacoma International Airport serves as an example to other airports facing wildlife habitat and ecological challenges. Additionally, it has completed an evaluation, which tracked the goals and achievements of the past year. The result is a progress report, “A Vision for 2014 and Beyond,” that outlines strategies for environmental sustainability for the next five years (Port of Seattle, 2009). The sustainability practices have three main goals, moving people and goods efficiently, managing natural resources wisely and promoting sustainable communities (Port of Seattle, 2009).

### **F) Fort Lauderdale/ Hollywood International Airport**

Fort Lauderdale/ Hollywood International Airport serves southern Florida with a passenger enplanement count of ten million in 2009 (Federal Aviation Administration Planning and Environmental Division, 2011). The airport's environmental sustainability plan aims at reduction of environmental impact and implementation of green operators. Some of the programs include a biodiesel and hybrid vehicle fleet, hazardous materials management, stormwater pollution prevention, heating and cooling efficiency and construction of a Green Belt Passive Park (Boward County Aviation Department, 2009). Fort Lauderdale/ Hollywood International Airport incorporated sustainable construction by using the green build rating system for LEED certification. This comprises of using recycled building materials, reflective roofing, low flow and automatic water shutoff (Boward County Aviation Department, 2009).

### **G) Munich Franz Josef Airport**

Munich airport opened in 1992 to replace the former Munich-Riem airport (Dempsey, 1999). Munich airport utilizes a four-pillar environmental strategy established through the German Air Transport Initiative. These four pillars are:

- Reduction of carbon emissions through technological advancements
- Efficient infrastructure and demand-based alignment of airport capacity
- Operation measures and optimization processes on ground
- Economic incentives (Munich Airport, 2008)

Their environmental management system comprises of; energy programs, air pollution and climate change, noise, water management, snow and ice control, waste management,

hazardous goods and materials, emergency management, planning and construction and conservation (Munich Airport, 2008).

Munich airport is one of the few with an advanced renewable energy project. The airport has been testing and utilizing rapeseed oil, biogas and bioethanol and it already has several vehicles running on alternative fuel. One of the most significant advances at the airport is the hydrogen project. The project was the first of its kind at any airport and its aim was to determine the reliability and efficiency of using hydrogen as an alternative source to run airport vehicles. Vehicles tested with hydrogen fuel include; buses, shuttle cars and forklifts (Wolfgang, 2010). Hydrogen is an alternative resource that is not readily available. However, the project at Munich airport has shown its benefits but it is quite a challenge because of the expense of obtaining hydrogen.

Biogas, bioethanol and solar are other forms of renewable energy in use at Munich airport. Biogas mainly powers the heat and power plant system, a small percentage is for airport vehicles, while some converted vehicles run on bioethanol. The long-term goal of the airport is to produce thirty percent of the airport's natural gas requirements with biogas. In addition, Munich airport has one of the largest solar projects and expects to save twelve thousand metric tons of carbon over a span of thirty years (Munich Airport, 2008).

Air quality monitoring at Munich airport was established a year before the airport opening. Since then, continuous results show that the airport operations have a low air quality impact to the surrounding environment due to the practices. There are two basic measuring methods in use, biomonitoring and passive. The biomonitoring tracks pollutant levels at the airport and the surrounding area while a passive method evaluates deposition



and precipitation at the airport. Emissions charges are included in the takeoff and landing fees. These charges are on individual aircraft nitrogen oxide and hydrocarbon output rated at three Euros per unit. This encourages airlines and manufacturers to operate and produce aircraft with lower emissions and environmental impacts. The airport, in cooperation with Munich University of Technology created an emissions simulation model to help with strategic decisions based on air quality. The simulation models along with the current practices have proven that a third runway would not significantly increase emissions (Munich Airport, 2008).

Other two EMP at Munich are wastewater and waste management. Wastewater is piped (according to type) to a local large-scale sewage treatment plant. The types of wastewater from the airport include domestic, industrial, rainwater etcetera. The airport has established an efficient way to deal with the wastewater from deicing along the taxiways. There is a deicer biodegradation system along the taxiways to capture wastewater. A geotextile mat and a layer on bentonite powder are buried approximately one point five metres below the ground, which converts the waste into carbon dioxide and water (Munich Airport, 2008). Fluids from aircraft deicing, along with melted ice, are collected, recycled. Groundwater, surface water precipitation and soil are tested occasionally to ensure non-existence of contaminants. Waste from the airport is either recycled or disposed at the municipal waste management operator and hazardous materials are stored in hazmat stores and in silos. Furthermore, the fuel supply and storage have an electronic monitoring and leak detection system that ensures no leakages of kerosene into the ground (Munich Airport, 2008). Support from the government and the embrace of technological advancements drive the airport's innovative EMP.

## **H) Oslo Airport**

Oslo Airport opened to replace Fornebu, which had exceeded its capacity. It began operations in 1998 and was expected to serve 17 million passengers a year (Dempsey, 1999). In the past year, it served 18 million passengers, and expansion plans are underway, to increase the capacity to 28 million passengers annually. Oslo's environmental management system comprises of aircraft noise, water and soil, energy, waste, air quality, health and working environment and climate change (Oslo Airport, 2007). The airport connects to the surrounding community through a transport network of highways and rail. The rail and natural water line were lowered to protect the infrastructure. Due to this, excess ground water is released into river Sogna but the water run-offs are treated at Gardermoen treatment plant (Oslo Airport, 2009).

A significant program is the health and work environment, which is comprised of employee training, safety and risk assessments, conducted regularly. Another is a climate change program involving participation in the Kyoto Protocol clean development mechanism. Oslo Airport also participates in emissions projects in developing countries such as wind power and biomass projects in India (Oslo Airport, 2007).

## **I) Athens International Airport**

Athens International Airport opened in 2001 replacing Athens Ellinikon and serves 16 million passengers annually (Athens International Airport, 2010). Athens airport EMS is the only one in Greece certified by ISO 14001:2004. Their EMS comprises of, aircraft noise, atmosphere, water, waste, natural environment and social initiatives. The atmosphere and climate change program initiatives include, converting the airport vehicle fleet into liquefied petroleum gas and hybrid technology, a natural gas

network, installation of a photovoltaic unit, optimization of the airport building automation system and participation in the European Green Light program. Athens Airport is the first airport to receive the European Green Light award (Athens International Airport, 2010).

In addition, the bio-monitoring program has survey results of birds, plants, vegetation and the ecosystem. There are no differences in results prior to the airport's opening and the status because of the airport's dedication to preserve the ecosystem. The wildlife control methods in use are bio acoustics, use of natural sounds and pyro-acoustics, use of loud sounds (Athens International Airport, 2010).

Athens also has a social initiatives EMP, educating and raising environmental awareness, and outreach to the community. This comprises of a recycling program for the schools of Artemis municipality, environmental scholarship, environmental information center and cultural heritage and construction and maintenance projects in urban green areas (Athens International Airport, 2010).

## FINDINGS

The following are the primary findings from the description and analysis of the *sustainable airport models'* environmental practices and programs.

1. The national *sustainable airport models* are ISO 14001 certified and used FAA order 5050.4B and AC 150/5050-8 to establish an EMS and EMP.
2. The initial funding for EMS and EMP is primarily through government. In the U.S., financial support for comes from AIP funding and specific program grants such as the VALE program.
3. The main catalysts of environmental sustainability are regulations, stakeholders' concerns, global trends, airport policy and corporate responsibility.
4. The major hindrances for implementing airport environmental sustainability practices are funding, staffing and general education or training.
5. The airports follow the Plan, Do Check Act model. Thus, they improve current practices and programs by identifying strengths and weakness during evaluations.
6. The airports develop environmental sustainability plans with the consideration of expected changes in regulations and policies.
7. The airports have a high community and stakeholder involvement and participation in the planning process.
8. All national and international airports have three common criteria as summarized in Table 5. These are policies, procedures and plans, alternative fuel vehicles and noise and acoustical quality

Table 5 is a summary of the innovative programs and practices of the *sustainable airport models*.



## RECOMMENDATIONS AND CONCLUSION

From the findings, other U.S. commercial service airports can adopt environmental practices and establish similar EMP. However, many airports still face hindrances to implementation of sustainable planning and implementation. These are funding, staffing, management, sustainability culture and the training, knowledge and understanding of sustainability practices. Public use airports are required to comply with the NEPA environmental regulations, state and local regulations. Therefore, public use airports establishing an EMS, EMP or practices, should utilize guidelines and available such as, AC 5050-8 Environmental Management Systems for Airport Sponsors, Order 5050.4B, NEPA Implementing Instructions for Airport Actions and state or local government requirements for the proposed actions or plans.

Airports identified funding as the main hindrance to airport sustainability implementation. However, the AC 5050-8 Environmental Management for Airport Sponsors, states that funding is provided for the initial establishment of an EMS. Thus, publicly owned airports, providing commercial service and as described in the NPIAS, have the advantage of receiving funds for an EMS. Additionally, AIP funds can be allocated towards environmental sustainability programs, as the *sustainable airport models* have done. VALE program is one of the *model airports' sustainability* programs, which is funded by AIP, passenger facility charges (PFC) and special program grants from the FAA.

The recommended goal towards environmental sustainability is a balanced approach, which includes addressing the key environmental challenges such as emissions, green transport plans, green architecture and use of renewable energy. A further step for

primary and nonprimary commercial service airports is inclusion of emission charges in landing fees, a program similar to Munich's Airport. Airports' existence in different environs requires modification of general guidelines for EMS and EMP to meet specific needs and challenges of each airport.

Airports can overcome the hindrances to environmental sustainability planning and lack of awareness by educating and training stakeholders and employees. The *sustainable airport models* show successful promotion of environmental awareness through seminars and training of employees for example the green building training series offered by Portland International Airport. Furthermore, lack of personnel can be partially tackled by allocating environmental management responsibility to current employees.

Stakeholders' concern for environmental sustainability is a present and future catalyst for sustainability and environmental management (Transportation Research Board, 2008). Therefore, airports serving the public should initiate and/or improve environmental programs through a cooperative effort, which includes the stakeholders and community participation. Community and stakeholder involvement is a practice portrayed by all the *sustainable airport models*.

All nine *sustainable airport models* address three key issues. First, are the policies, procedures and plans. In order for an airport to have successful EMS and EMP, there must be concrete planning, according to the airport policies and procedures that ensure continuous improvement. Second, alternative fuel vehicles are a global trend in the transportation industry. Thus, airports are cutting fuel cost by using the alternative fueled vehicles, apart from the VALE program. Third, noise and acoustical quality is the

most challenging issue for all airports. Nevertheless, these airports have tackled the issued through noise studies and continuous monitoring. Thus, other airports need to be aware of the global sustainability trends.

The *sustainable airport models* illustrate how proper planning facilitates easier development and growth, particularly through community involvement. However, there are certain factors that should be accounted for in the process of developing EMS, EMP and long-term sustainability planning. The described processes in the FAA advisor circulars are general guidelines and do not account for unpredictable circumstances such as, lack of support, disagreements with stakeholders and so forth. Unpredictability of the process is a factor that should be noted thus, there should be greater vigilance, particularly with new programs. Additionally, no source has been identified for the continuous funding of established EMP, with the exception of the VALE program. The assumption is that, there is a yearly allocation of AIP funds towards the existing and new EMP. Thus, airports initiating environmental sustainability projects are advised to seek in-depth research on additional and / or continuous sources of funding. Most important aspect is that, each airport initiating sustainability planning, EMS or and EMP should tailor the plan or program to meet the regulator requirements and long-term sustainability goals.



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## **APPENDICES**

## APPENDIX A - DEFINITIONS

ACRP – Airport Cooperative Research Program is an applied research program on problems shared by airport operating agencies. The program is managed by the Transportation Research Board (TRB) and sponsored by the FAA. The TRB promotes innovation and progress through research

AIP – Airport Improvement Program provide grants for the development of public-use airports included in the NPIAS

BURNDTLAND COMMISSION – Also known as, World Commission on Environment and Development (WCED) was established under the United Nations for environmental management to ensure sustainable global development

EMS – Environmental Management System are practices allowing organizations to strategically address environmental issues. According to the FAA, “EMS implementation reflects accepted management principles based on the “Plan, Do, Check, Act,” model. That model uses a systematic process to identify goals, complete them, determine progress, and make changes to ensure continual improvement”

EMP – Environmental Management Program are practices and programs that define an airport’s EMS or sustainability management practices

FAA – Federal Aviation Administration is the regulatory body for aviation

ISO 14001<sup>2</sup> – International Organization for Standardization series 14001 are voluntary international standards for EMS elements such as auditing performance and life-cycle assessment or the “Plan, Do, Check, Act” model.

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<sup>2</sup>ISO 14001 refers to “ISO 14001 requirements for an EMS can be used for certification, registration, and/or self declaration. An EMS must satisfy one of the recognized standards if an airport sponsor is seeking Federal financial support for its development. An airport that receives Federal aid to develop an

LEED – Leadership in Energy & Environmental Design. A green building certification system or rating system developed by the U.S. Green Building Council (USGBC). It provides verification that a building is designed in environmentally friendly ways

NASA – National Aeronautics and Space Administration oversees space exploration, scientific and aeronautics research

NEPA – National Environmental Policy Act (1970) promotes protection, maintenance and enhancement of the environment

SAGA – Sustainable Aviation Guidance Alliance is a volunteer group assisting airports in planning, implementing and maintaining sustainability programs

VALE – Voluntary Airport Low Emissions Program is a national program to reduce airport ground emissions at commercial service airports

NPIAS<sup>3</sup> – National Plan of Integrated Airport Systems are airports significant to the national air transportation and are eligible to receive federal funds under the AIP. These airports are commercial service, hubs, nonhub primary, nonprimary, reliever and general aviation airports.

*Commercial Service Airports* – Public airports receiving scheduled passenger service and having 2,500 or more enplaned passengers per year

*Primary Commercial Service Airports* – Public airports receiving more than 10,000 annual passenger enplanements

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*EMS must keep the EMS current, without further Federal financial aid”* (Federal Aviation Administration Planning and Environmental Division, 2007).

<sup>3</sup>NPIAS refers to “*NPIAS is used by FAA in administering the AIP. It supports the goals identified in the FAA Flight Plan for safety and capacity by identifying airports and airport improvements that will help achieve those goals. Fifty-seven percent of the development is intended to rehabilitate existing infrastructure and keep airports to standards for the aircraft that use them. Forty-three percent of the development in the report is intended to accommodate growth in travel, including more passengers, cargo and activity, and larger aircraft.*” (Federal Aviation Administration, October 2010).

*Nonhub Primary Commercial Service* – Commercial service airports that enplane less than 0.05 percent of all commercial passenger enplanements but have more than 10,000 annual enplanements

*NonPrimary Commercial Service* – Commercial service airports that have from 2,500 to 10,000 annual passenger enplanements

*Reliever Airports* – These airports must have 100 or more based aircraft or 25,000 annual itinerant operations

*General Aviation Airports (in the NPIAS)* – All other airports, that do not receive scheduled commercial service, or have locally based aircraft, and are at least 20 miles from the nearest NPIAS airport

*Hub* – FAA defines a hub as a very busy primary airport and are grouped into three, large, medium and small hubs

*Large Hub* – Airports that each account for at least 1 percent of total U.S. passenger enplanements

*Medium Hub* – Airports that each account for between 0.25 percent and 1 percent of total U.S. passenger enplanements

*Small Hub* – Airports that enplane 0.05 percent to 0.25 percent of total U.S. passenger enplanements



## APPENDIX B - National Environmental Policy Act (NEPA) Airports' special purpose laws

Table B1  
*NEPA Requirements for Airports*

Statute or Executive Order	Implementing Regulation or Guidance	Notes
<b>Statutes</b>		
49 USC. Subchapter I, section 303.c.	Formerly, Section 4(f) of the Dept. of Transportation Act.	
49 USC Subpart B, Chapter 471, section 47106.(c).	Environmental Requirements for new airports, new runways, or major runway extensions.	
American Indian Religious Freedom Act	43 CFR, Parts 7.32, 7.7	
Anadromous Fish Conservation Act	50 CFR, Part 401	
Archeological and Historic Preservation Act	36 CFR, Part 68	
Archeological Resources Protection Act	25 CFR, Part 262 36 CFR, Part 79 43 CFR, Parts 3, 7	
Clean Air Act	40 CFR, Part 93	See Subpart B
Coastal Barrier Resources Act		
Coastal Zone Management Act	15 CFR, Part 930	See Subparts C and D
Comprehensive Environmental Response, Conservation, and Liability Act	40 CFR, Part 307	See Subpart J for more information on various topics addressed for this law.
Endangered Species Act, Section 7	50 CFR, Parts 17, 402	Part 17 lists species.
Farmland Protection Policy Act	7 CFR, Part 657, 658	
Land and Water Conservation Act, section 6(f)	36 CFR, Part 59	
Magnuson-Stevens Act	50 CFR, Part 600	See Subpart J for Essential Fish Habitats and Subpart K for Coordination and Consultation.
Marine Mammal Protection Act	50 CFR, Part 18, 216	
Migratory Bird Treaty Act	50 CFR, Part 21	
National Historic Preservation Act	36 CFR, Parts 800 <i>et. seq.</i>	
National American Graves Repatriation Act	43 CFR, Part 10 25 CFR, Part 262.8	When airports occur on Indian reservation land or Federal lands.
Resource Conservation and Recovery Act	40 CFR, Part 256	See Subpart E.
Safe Drinking Water Act	40 CFR, Part 141	
Uniform Relocation and Real Property Acquisition Policy Act	49 CFR, Part 49 FAA Order 5100.38B	
Wild and Scenic Rivers Act	36 CFR, Part 297	

Source: FAA Order 5050.4B NEPA Implementing Instructions for Airport Actions (Federal Aviation Administration Office of Airports (ARP), 2006).

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